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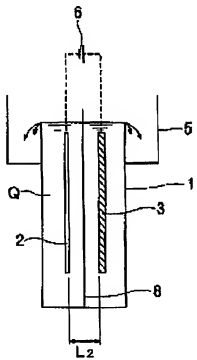
(54) SUBSTRATE PLATING APPARATUS

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a substrate plating apparatus that can uniformize primary current distribution between cathode and anode and can be reduced in size.
SOLUTION: In a substrate plating apparatus in which a substrate 2 to be plated and an anodic electrode 3 are placed opposite to each other in a plating tank 1 contg. a plating soln., an ion exchange membrane or a porous neutral diaphragm 8 is disposed between the substrate 2 and the anodic electrode 3. The anodic electrode 3 is a soluble anodic electrode and the ion exchange membrane or the porous neutral diaphragm 8 is a cation exchange membrane that passes only ions leached from the soluble anodic electrode.



* NOTICES *

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2.**** shows the word which can not be translated.
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CLAIMS

[Claim(s)]
[Claim 1]In a substrate plating device of composition of having arranged a substrate to be plated and an anode electrode which plate in a plating bath which accommodated a plating solution face to face, A substrate plating device having arranged an ion-exchange membrane or porosity neutral barrier membrane between said substrate to be plated and an anode electrode, and classifying said plating bath into the plating board side field and the anode electrode side field by this ion-exchange membrane or porosity neutral barrier membrane.
[Claim 2]A substrate plating device which said anode electrode is a soluble anode electrode in the substrate plating device according to claim 1, and is characterized by using said ion-exchange membrane as cation exchange membrane which penetrates only ion which dissolved from an anode electrode of this solubility.
[Claim 3]In the substrate plating device according to claim 1 or 2, an opening and closing valve is provided in an entrance of a plating solution of said anode electrode side field classified by said ion-exchange membrane or porosity neutral barrier membrane, A substrate plating device constituting so that a plating solution of this anode electrode side field may join a plating solution which flowed out of said plating board side field via this opening and closing valve.
[Claim 4]A substrate plating device forming a filter in an exit of a plating solution of said anode electrode side field classified by said ion-exchange membrane or porosity neutral barrier membrane in the substrate plating device according to claim 3.
[Claim 5]In a substrate plating device of composition of having arranged a substrate to be plated and an anode electrode which plate in a plating bath which accommodated a plating solution face to face, Use said anode electrode as an anode electrode of insolubility, and barrier membrane which consists of porosity neutral barrier membrane or an anode ion-exchange membrane between this anode electrode and a substrate to be plated is arranged, A substrate plating device classifying said plating bath into the plating board side field and the anode electrode side field by this porosity neutral barrier membrane or an anode ion-exchange membrane.
[Claim 6]A substrate plating device, wherein said porosity neutral barrier membrane or an anode ion-exchange membrane is in contact with a board which served as a shield which amends primary current distribution between said anode electrode and a substrate to be plated in the substrate plating device according to claim 5.
[Claim 7]A substrate plating device circulating a plating solution of said plating board side field classified by said barrier membrane, and the anode electrode side field by a separate circulation means in the substrate plating device according to claim 5 or 6, respectively.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the plating device which performs metal plating processing to substrates, such as a semiconductor wafer.
[0002]
[Description of the Prior Art]Drawing 5 is a figure showing the outline composition of this conventional kind of substrate plating device. As shown in drawing 5, the conventional substrate plating device counters and arranges the substrate 2 to be plated and the anode electrodes 3, such as a semiconductor wafer, in the plating bath 1 which accommodated plating solution Q, and. The shield 4 is arranged between this substrate 2 to be plated and the anode electrode 3, and predetermined voltage is impressed from the plating power supply 6 between the substrate 2 to be plated and the anode electrode 3, and it constitutes so that a plating film may be formed in the surface of the substrate 2 to be plated. 5 is a collecting gutter for collecting plating solution Q which overflowed the upper bed of the plating bath 1.
[0003]
[Problem(s) to be Solved by the Invention]What is necessary is just to make it the primary current distribution between the negative pole (substrate 2 to be plated) and the anode electrode 3 become uniform in the plating device of the above-mentioned composition, in order to raise the homogeneity of the thickness of the plating film formed in the surface of the substrate 2 to be plated. Although what is necessary is just to enlarge distance between the negative pole (substrate 2 to be plated) and the anode electrode 3 in order to make this primary current distribution uniform, for enlarging this distance, it is necessary to enlarge the plating bath 1 and by extension, a plating device, and contrary to the miniaturization of a plating device.
[0004]When electrolytic plating is coppering, phosphorus-containing copper is used for a soluble anode electrode in many cases, when such a soluble anode electrode is used, management of the black film on the surface of an anode electrode is difficult, and the particle contamination produced from this black film also poses a big problem.
[0005]If an anode electrode is made into insolubility, this problem will be lost, but there is a problem that the supplying method of the Cu ions to a plating solution poses a problem, and this additive agent is disassembled, and the this disassembled additive agent adheres to substrates, such as a semiconductor wafer, to be plated.
[0006]It aims at providing the substrate plating device which this invention was made in view of the above-mentioned point, and can make uniform primary current distribution between the negative pole and the anode, and can miniaturize a plating device.
[0007]It aims at providing the plating device with which a substrate to be plated is not polluted by particle-ization of a black film even if it uses a dissolution positive electrode.
[0008]Without a black film arising on the anode electrode surface, the anode electrode of insolubility is used for an anode electrode, and the additive agent disassembled under the influence of an anode electrode aims at providing the substrate plating device which does not adhere to a substrate to be plated.
[0009]
[Means for Solving the Problem]In order to solve an aforementioned problem the invention according to claim 1, In a substrate plating device of composition of having arranged a substrate to be plated and an anode electrode which plate in a plating bath which accommodated a plating solution face to face, An ion-exchange membrane or porosity neutral barrier membrane has been arranged between a substrate to be plated and an anode electrode, and a plating bath was classified into the plating board side field and the anode electrode side field by this ion-

exchange membrane or porosity neutral barrier membrane.

[0010]By arranging an ion-exchange membrane or porosity neutral barrier membrane between a substrate to be plated and an anode electrode as mentioned above, An increase role of electrical resistance of a plating solution is played, the same effect as having enlarged distance between a substrate to be plated and an anode electrode is acquired, and this ion-exchange membrane or the porosity neutral barrier membrane can make an interval of a substrate to be plated and an anode electrode small.

[0011]In the substrate plating device according to claim 1, an anode electrode is a soluble anode electrode and the invention according to claim 2 used an ion-exchange membrane as cation exchange membrane which penetrates only ion which dissolved from an anode electrode of this solubility.

[0012]By considering it as cation exchange membrane which penetrates only ion which dissolved an ion-exchange membrane from an anode electrode as mentioned above, an impurity which dissolves from an anode electrode can be intercepted by this cation exchange membrane, and it becomes possible to lessen particle in a plating solution of the plating board side field as much as possible.

[0013]In the substrate plating device according to claim 1 or 2 the invention according to claim 3, An opening and closing valve was provided in an entrance of a plating solution of the anode electrode side field classified by an ion-exchange membrane or porosity neutral barrier membrane, and it constituted so that a plating solution of this anode electrode side field might join a plating solution which flowed out of the plating board side field via this opening and closing valve.

[0014]Composition a plating solution from the anode electrode side field and a plating solution from the plating board side field are made to join as mentioned above, Namely, although particle is emitted into a plating solution with a black film which adhered to an anode electrode by constituting so that a plating solution from the anode electrode side field and a plating solution from the plating board side field may join on the outside of a plating bath, This particle is not mixed in a plating solution of the plating board side field.

[0015]The invention according to claim 4 formed a filter in an exit of a plating solution of the anode electrode side field classified by an ion-exchange membrane or porosity neutral barrier membrane in the substrate plating device according to claim 3.

[0016]By forming a filter in an exit of a plating solution of the anode electrode side field as mentioned above, particle emitted into a plating solution is removed from a black film adhering to an anode electrode by this filter.

[0017]In a substrate plating device of composition of that the invention according to claim 5 has countered and arranged a substrate to be plated and an anode electrode which plate in a plating bath which accommodated a plating solution, An anode electrode was used as an anode electrode of insolubility, barrier membrane which consists of porosity neutral barrier membrane or an anode ion-exchange membrane between this anode electrode and a substrate to be plated has been arranged, and a plating bath was classified into the plating board side field and the anode electrode side field by this porosity neutral barrier membrane or an anode ion-exchange membrane.

[0018]Since barrier membrane which consists of porosity neutral barrier membrane or an anode ion-exchange membrane between the above-mentioned anode electrode and a substrate to be plated has been arranged, Since a disassembled additive agent does not infiltrate into the plating board side field, without disassembling add-in material on the anode electrode surface since a fresh plating solution does not touch the anode electrode surface, a life of a plating solution becomes long.

[0019]The invention according to claim 6 is in contact with a board which served as a current shield of a role with which porosity neutral barrier membrane or an anode ion-exchange membrane amends primary current distribution of a between very much in the substrate plating device according to claim 5.

[0020]A plating solution of the plating board side field where the invention according to claim 7 was classified by barrier membrane in the substrate plating device according to claim 5 or 6, and the anode electrode side field is circulated by a separate circulation means, respectively.

[0021]By circulating a plating solution of the plating board side field and the anode electrode side field by a separate circulation means as mentioned above, respectively, a plating solution which flows through the anode electrode side field flows outside together with O_2 gas which comes out from an anode electrode side apart from a plating solution which flows through a substrates face to be plated.

[0022]

[Embodiment of the Invention]the following and an embodiment of the invention -- an example is explained based on a drawing. Drawing 1 is a figure showing the outline composition of the substrate plating device of this

invention. In the figure, the portion which attached drawing 5 and identical codes shows a same or considerable portion. This substrate plating device arranges the cation exchange membrane 8 between the negative pole (substrate 2 to be plated) and the anode electrode 3 so that it may illustrate.

[0023]As mentioned above, what is necessary is for what is necessary to be just to make it the primary current distribution between the substrate 2 to be plated and the anode electrode 3 become uniform, in order to raise the homogeneity of the plating film thickness of the surface of the substrate 2 to be plated, and just to enlarge distance between the substrate 2 to be plated and the anode electrode 3, in order to make this primary current distribution uniform. However, since the large plating bath 1 as mentioned above is needed if distance between the substrate 2 to be plated and the anode electrode 3 is enlarged, It was made to become equivalent to having enlarged distance between the substrate 2 to be plated and the anode electrode 3 here by arranging the cation exchange membrane 8 between the substrate 2 to be plated and the anode electrode 3, so that it may explain later. The cation exchange membrane 8 has classified the inside of the plating bath 1 into two fields of the arrangement area of the substrate 2 to be plated, and the arrangement area of the anode electrode 3.

[0024]If the interval of the substrate 2 of the substrate plating device of the conventional composition to be plated and the anode electrode 3 which shows interval L_2 and drawing 5 the interval of the substrate 2 of the substrate plating device of this invention to be plated and the anode electrode 3 shown in drawing 1 is made into interval L_1, It becomes $L_1 >> L_2$ even if it similarly makes primary current distribution uniform. That is, in the substrate plating device of this invention, interval L_2 between the substrate 2 to be plated and the anode electrode 3 can be made small making primary current distribution uniform as compared with a conventional example.

[0025]Drawing 2 is a figure for explaining the effect which has arranged the cation exchange membrane 103 between the negative pole 101 and the anode 102. Suppose that there is a level difference so that it may illustrate to the field of the negative pole 101 now, and the distance between the negative pole 101 and the anode 102 the current density of the portion of l_1 i_1, When distance makes specific resistance of i_2 and plating solution Q the penetration electrical resistance R of rho and the cation exchange membrane 103 for the current density of the portion of l_2, it is $i_2/i_1=(l_1 \text{ rho}+R)/(l_2 \text{ rho}+R)$.

$= (l_2+**l) \text{ rho}+R) / (l_2 \text{ rho}+R)$

$= 1+(**l\text{rho})/(l_2 \text{ rho}+R)$

It becomes.

[0026]Therefore, in order to carry out the homogeneity of the primary current distribution, what is necessary will be just to bring current density ratio i_2/i_1 close to one. Instead of enlarging distance l_2 of the negative pole 101 and the anode 102 here, in order to bring current density ratio i_2/i_1 close to one, If the cation exchange membrane 103 which plays the role of the electrical resistance of a plating solution is arranged between the negative pole 101 and the anode 102, the same effect as having enlarged distance l_2 of the negative pole 101 and the anode 102 will be acquired. That is, in spite of having made inter electrode distance small by arranging the cation exchange membrane 103 between the negative pole 101 and the anode 102, an effect equivalent to having used big distance is acquired, and a substrate plating device can be made small by extension.

[0027]A substrate plating device is used as Cu plating device which forms a Cu plated film in the substrate 2 to be plated in drawing 1, If it is considered as the cation exchange membrane which penetrates only the Cu ions which dissolved the cation exchange membrane 8 from the soluble anode electrode 3 when the anode electrode 3 is used as a soluble anode electrode and a plating solution is used as a copper sulfate solution, It becomes possible to intercept the impurity which dissolves from the anode electrode 3 by the cation exchange membrane 8, and it becomes possible to lessen particle in the plating solution of the substrate [to be plated] 2 side field as much as possible.

[0028]Although the cation exchange membrane 8 has been arranged between the substrate 2 to be plated and the anode electrode 3 in the above-mentioned example, the same operation effect is obtained also by the porosity neutral barrier membrane which changes to this cation exchange membrane 8, and has a particle removal action.

[0029]With electrical energy, the above-mentioned cation exchange membrane has the character to which permeation separation of the ion is carried out selectively, and can use a commercial thing. For example, there

are a trade name by Asahi Glass Co., Ltd. "SEREMION", etc. As porosity neutral barrier membrane, the porous membrane which has a very small and uniform aperture which consists of synthetic resins is used. For example, a polyester nonwoven fabric is used for aggregate by Yuasa Ionics, Inc., and the quality of a film material uses the trade name "YUMICRON" of polyvinylidene fluoride + titanium oxide.

[0030]Drawing 3 is a sectional view showing the example of concrete composition of the plating bath of the substrate plating device of this invention. The plating bath 11 possesses the main part 15 of a plating bath, and the side plate 16 so that it may illustrate. The crevice 14 in which a plating solution is accommodated is formed in the main part 15 of a plating bath, and the lower end of the side plate 16 can open now and close the opening of the crevice 14 of the main part 15 of a plating bath by a hinge mechanism (not shown). The soluble anode electrode 17 is formed in the field by the side of the side plate 16 of the bottom plate 15a of the main part 15 of a plating bath, and the field by the side of the main part 15 of a plating bath of the side plate 16 is equipped with the substrate 18 which plates a semiconductor wafer etc. to be plated. Where the opening of the crevice 14 is closed with the side plate 16, the packing 20 contacts the field of the substrate 18 with which this side plate 16 was equipped to be plated, and let the crevice 14 of the main part 15 of a plating bath be a closed space.

[0031]So that it may be located between the substrate 18 to be plated and the soluble anode electrode 17, where the side plate 16 is closed in the crevice 14 of the main part 15 of a plating bath, That is, cation exchange membrane or the porosity neutral barrier membrane 19 is formed so that the space of the crevice 14 may be classified into the plating board side field 14-1 and the anode electrode side field 14-2 (isolation). The upper header 12 and the lower header 13 are formed in the upper and lower sides of the main part 15 of a plating bath, and the opening 12a of the upper header 12 and the opening 13a of the lower header 13 are open for free passage to the plating board side field 14-1.

[0032]The plating solution entrances 21 and 22 which are open for free passage to the vertical section of the anode electrode side field 14-2 are formed, The opening and closing valves 25 and 26 are formed in these plating solution entrances 21 and 22 via the filters 23 and 24, respectively, and these opening and closing valves 25 and 26 are further connected to the piping 27 connected to the opening 12a of the upper header 12, respectively, and the piping 28 connected to the opening 13a of the lower header 13. That is, the plating solution included in the plating board side field 14-1 of the main part 15 of a plating bath and the anode electrode side field 14-2 is divided on the outside of the main part 15 of a plating bath, and the plating solution which comes out joins on the outside of the main part 15 of a plating bath. Through the filters 23 and 24, the plating solution which comes out of the anode electrode side field 14-2 flows out, and ON is carried out. In drawing 3, 29 and 30 are check valves, respectively.

[0033]In the plating bath 11 of the above-mentioned composition, plating solution Q from the piping 28 is supplied to the plating board side field 14-1 through the opening 13a of the lower header 13, and it is supplied also to the anode electrode side field 14-2 through the opening and closing valve 26 and the filter 24. By this, plating solution Q flows through the plating board side field 14-1 and the anode electrode side field 14-2, as shown in the arrow A, Plating solution Q of the plating board side field 14-1 flows into the piping 27 through the opening 12a of the upper header 12, and plating solution Q of the anode electrode side field 14-2 lets the plating solution entrance 21, the filter 23, and the opening and closing valve 25 pass, Plating solution Q from the plating board side field 14-1 which flows through the piping 27 is joined.

[0034]Although particle arises in the plating solution of the anode electrode side field 14-2 with the black film adhering to the surface of the anode electrode 17 in the above substrate plating devices, So that this particle may not become together with plating solution Q of the plating board side field 14-1, Plating solution Q which flows out of the anode electrode side field 14-2 is constituted so that it may flow out of the plating board side field 14-1 through the filter 23 and the opening and closing valve 25 and may join on the outside of plating solution Q and the main part 15 of a plating bath.

[0035]When picking out the substrate 18 to be plated from the plating bath 11, plating solution Q of the plating board side field 14-1 discharges, but as for plating solution Q of the anode electrode side field 14-2, it is not preferred to discharge in order to prevent the black film of the surface of the anode electrode 17 forming a white film. Then, it becomes possible to take out the substrate 18 to be plated, without discharging plating solution Q of the anode electrode side field 14-2 by closing the opening and closing valves 25 and 26, when picking out the substrate 18 to be plated from the plating bath 11.

[0036]Although the above-mentioned example showed the example which passes plating solution Q from a lower part to the upper part to the plating board side field 14-1 of the main part 15 of a plating bath, and the anode

electrode side field 14-2, It may be made to pass the flow direction of plating solution Q caudad from the upper part conversely, and may be made to pass it from the upper part by turns from a lower part and a lower part to the upper part. Predetermined voltage is impressed between the substrate 18 to be plated and the anode electrode 17.

[0037]From the cation exchange membrane 19 being arranged between the substrate 18 to be plated and the anode electrode 17 as mentioned above. It becomes equivalent to the electrical resistance of plating solution Q between the substrate 18 to be plated and the anode electrode 17 having increased as mentioned above, The distance between the substrate 18 to be plated and the anode electrode 17 can carry out uniformly primary current distribution between the substrate 18 to be plated and the anode electrode 17 to it being small, and can form the plating film of uniform thickness in the surface of the substrate 18 to be plated.

[0038]Since the cation exchange membrane 19 will penetrate only the Cu ions which dissolved from the soluble anode electrode 17 if the anode electrode 17 is used as a soluble electrode (copper plate) and plating solution Q is used as a copper sulfate solution, It becomes possible to intercept the impurity which dissolves from the anode electrode 17 by the cation exchange membrane 19, and it becomes possible to lessen particle in plating solution Q by the side of the substrate 18 to be plated as much as possible.

[0039]Drawing 4 is a sectional view showing the example of concrete composition of the plating bath of the substrate plating device of this invention. The plating bath 11 shown in drawing 4 a different point from the plating bath 11 shown in drawing 3, It is the point of having arranged the barrier membrane 31 which consists of porosity neutral barrier membrane or an anode ion-exchange membrane between this anode electrode 33 and the substrate 18 to be plated, using the anode electrode of insolubility as the anode electrode 33, and having classified the plating bath 11 into the plating board side field 14-1 and the anode electrode side field 14-2. The barrier membrane 31 is formed in contact with the board 32 which served as the current shield for making primary current distribution uniform between the anode electrode 33 and the substrate 18 to be plated.

[0040]In the plating bath 11 of the above-mentioned composition, although a graphic display is omitted, the plating solution which circulates through the plating board side field 14-1, and the plating solution which circulates through the anode electrode side field 14-2 are constituted, respectively so that it may be made to circulate with a separate circulating pump.

[0041]As mentioned above, since the barrier membrane 31 which consists of porosity neutral barrier membrane or an anode ion-exchange membrane between the anode electrode 33 of insolubility and the substrate 18 to be plated has been arranged and a fresh plating solution does not touch the surface of the anode electrode 33, an additive agent is not disassembled and the life of plating solution Q becomes long.

[0042]By circulating the plating solution of the plating board side field 14-1 and the anode electrode side field 14-2 with a separate circulating pump, respectively, The plating solution which flows through the anode electrode side field 14-2 flows outside together with O_2 gas which comes out from the field of the anode electrode 33 apart from the plating solution which flows through the 18th page of a substrate to be plated.

[0043]

[Effect of the Invention]As explained above, according to the invention given in this application each claim, the following outstanding effects are acquired.

[0044]Since an ion-exchange membrane or porosity neutral barrier membrane has been arranged between a substrate to be plated and an anode electrode according to the invention according to claim 1, It can become equivalent to the electrical resistance of the plating solution between a substrate to be plated and an anode electrode having increased, primary current distribution between a substrate to be plated and an anode electrode can be uniformly carried out to the distance of a substrate to be plated and an anode electrode being small, and a uniform plating film can be formed in the surface of a substrate to be plated. Therefore, the miniaturization of a substrate plating device can be attained.

[0045]Since according to the invention according to claim 2 an anode electrode is a soluble anode electrode and the ion-exchange membrane was used as the cation exchange membrane which penetrates only the ion which dissolved from the anode electrode of this solubility, It becomes possible to intercept the impurity which dissolves from an anode electrode by cation exchange membrane, and it becomes possible to lessen particle in the plating solution by the side of a substrate to be plated as much as possible.

[0046]According to the invention according to claim 3, an opening and closing valve is provided in the entrance and entrance of the anode electrode side field which were classified by an ion-exchange membrane or porosity neutral barrier membrane, So that the plating solution of this anode electrode side field may join the plating

solution which flowed out of the plating board side field via this opening and closing valve Composition, That is, since it constitutes so that the plating solution of the anode electrode side field and the plating solution of the plating board side field may join on the outside of a plating bath, the particle emitted into the plating solution with the black film adhering to an anode electrode does not mix in the plating solution of the plating board side field.

[0047]Since the filter was formed in the exit of the plating solution of the anode electrode side field classified by an ion-exchange membrane or porosity neutral barrier membrane according to the invention according to claim 4, particle arises in a plating solution with the black film adhering to an anode electrode, but. This particle is removed by this filter.

[0048]Since the barrier membrane which consists of porosity neutral barrier membrane or an anode ion-exchange membrane between an anode electrode and a substrate to be plated has been arranged according to the invention according to claim 5 or 6, Without a fresh plating solution touching the anode electrode surface, it can lose that the disassembled additive agent infiltrates into the plating board side field, and the life of a plating solution becomes long.

[0049]By circulating the plating solution of the plating board side field and the anode electrode side field by a separate circulation means, respectively according to the invention according to claim 7, The plating solution which flows through the anode electrode side field is emitted outside together with O_2 gas which comes out from the field of an anode electrode apart from the plating solution which flows through the plating board side field.

[Translation done.]

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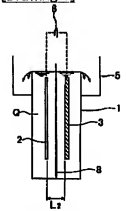
DRAWINGS

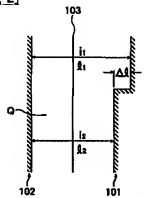
[Drawing 1]



1:メッキ槽
2:被メッキ基板
3:陽極電極
5:補助極
8:メッキ電源
9:陽イオン交換膜又は多孔質中性隔膜

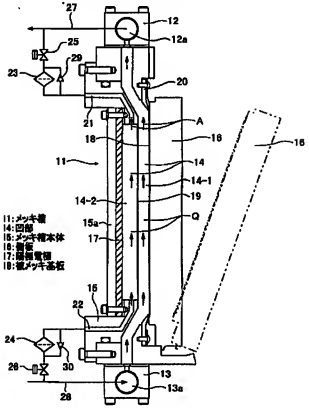
本発明の基板メッキ装置の概略構成

[Drawing 2]



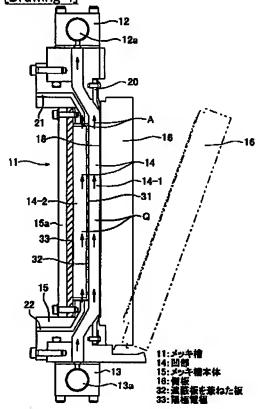
陰極と陽極の間に陽イオン交換膜又は多孔質中性隔膜を配置した効果

[Drawing 3]



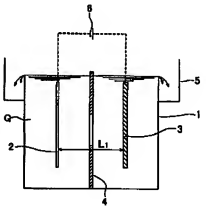
本発明の基板メッキ装置のメッキ槽の具体的構成例

[Drawing 4]



本発明の基板メッキ装置のメッキ槽の具体的構成例

[Drawing 5]



1:メッキ槽
2:被メッキ基板
3:陽極電極
4:遮蔽板
5:補助陰
6:メッキ電源

従来の基板メッキ装置の概略構成

[Translation done.]

CORRECTION OR AMENDMENT

[Kind of official gazette]Printing of amendment by the regulation of 2 of Article 17 of Patent Law
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H01L 21/288
[FI]

C25D 17/00 H

C25D 7/12

H01L 21/288 E
[Written amendment]
[Filing date]December 11, Heisei 15 (2003.12.11)
[Amendment 1]
[Document to be Amended]Specification
[Item(s) to be Amended]Whole sentence
[Method of Amendment]Change
[The contents of amendment]
[Title of the Invention]Substrate plating device
[Claim(s)]
[Claim 1]In a substrate plating device of composition of having arranged a substrate to be plated and an anode electrode which plate in a plating bath which accommodated a plating solution face to face,
A substrate plating device having arranged porosity neutral barrier membrane which has an ion-exchange membrane or a particle removal action between said substrate to be plated and an anode electrode.
[Claim 2]In the substrate plating device according to claim 1,
A substrate plating device classifying said plating bath into the plating board side field and the anode electrode side field by said ion-exchange membrane or porosity neutral barrier membrane.
[Claim 3]In the substrate plating device according to claim 1 or 2,
A substrate plating device which said anode electrode is a soluble anode electrode, and is characterized by using said ion-exchange membrane as cation exchange membrane which penetrates only ion which dissolved from an anode electrode.
[Claim 4]In the substrate plating device according to claim 1, 2, or 3,
A substrate plating device constituting so that an opening and closing valve may be provided in an entrance of a

plating solution of said anode electrode side field classified by said ion-exchange membrane or said porosity neutral barrier membrane and a plating solution of this anode electrode side field may join a plating solution which flowed out of said plating board side field via this opening and closing valve.
[Claim 5]In the substrate plating device according to claim 4,
A substrate plating device forming a filter in an exit of a plating solution of said anode electrode side field classified by said ion-exchange membrane or said porosity neutral barrier membrane.
[Claim 6]In a substrate plating device of composition of having arranged a substrate to be plated and an anode electrode which plate in a plating bath which accommodated a plating solution face to face,
A substrate plating device having arranged barrier membrane which consists of porosity neutral barrier membrane or an anode ion-exchange membrane which uses said anode electrode as an anode electrode of insolubility, and has a particle removal action between this anode electrode and a substrate to be plated.
[Claim 7]In the substrate plating device according to claim 6,
A substrate plating device classifying said plating bath into the plating board side field and the anode electrode side field by said porosity neutral barrier membrane or an anode ion-exchange membrane.
[Claim 8]In the substrate plating device according to claim 6 or 7,
A substrate plating device, wherein said porosity neutral barrier membrane or an anode ion-exchange membrane is in contact with a board which served as a shield which amends primary current distribution between said anode electrode and a substrate to be plated.
[Claim 9]In the substrate plating device according to claim 6, 7, or 8,
A substrate plating device circulating a plating solution of said plating board side field classified by said barrier membrane, and the anode electrode side field by a separate circulation means, respectively.
[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the plating device which performs metal plating processing to substrates, such as a semiconductor wafer.
[0002]
[Description of the Prior Art]
Drawing 5 is a figure showing the outline composition of this conventional kind of substrate plating device. As shown in drawing 5, the conventional substrate plating device counters and arranges the substrate 2 to be plated and the anode electrodes 3, such as a semiconductor wafer, in the plating bath 1 which accommodated plating solution Q, and. The shield 4 is arranged between this substrate 2 to be plated and the anode electrode 3, and predetermined voltage is impressed from the plating power supply 6 between the substrate 2 to be plated and the anode electrode 3, and it constitutes so that a plating film may be formed in the surface of the substrate 2 to be plated. 5 is a collecting gutter for collecting plating solution Q which overflowed the upper bed of the plating bath 1.
[0003]
[Problem(s) to be Solved by the Invention]
What is necessary is just to make it the primary current distribution between the negative pole (substrate 2 to be plated) and the anode electrode 3 become uniform in the plating device of the above-mentioned composition, in order to raise the homogeneity of the thickness of the plating film formed in the surface of the substrate 2 to be plated. Although what is necessary is just to enlarge distance between the negative pole (substrate 2 to be plated) and the anode electrode 3 in order to make this primary current distribution uniform, for enlarging this distance, it is necessary to enlarge the plating bath 1 and by extension, a plating device, and contrary to the miniaturization of a plating device.
[0004]
When electrolytic plating is coppering, phosphorus-containing copper is used for a soluble anode electrode in many cases, when such a soluble anode electrode is used, management of the black film on the surface of an anode electrode is difficult, and the particle contamination produced from this black film also poses a big problem.
[0005]
If an anode electrode is made into insolubility, this problem will be lost, but there is a problem that the supplying method of the Cu ions to a plating solution poses a problem, and this additive agent is disassembled, and the this disassembled additive agent adheres to substrates, such as a semiconductor wafer, to be plated.

[0006]
It aims at providing the substrate plating device which this invention was made in view of the above-mentioned point, and can make uniform primary current distribution between the negative pole and the anode, and can miniaturize a plating device.
[0007]
It aims at providing the plating device with which a substrate to be plated is not polluted by particle-ization of a black film even if it uses a dissolution positive electrode.
[0008]
Without a black film arising on the anode electrode surface, the anode electrode of insolubility is used for an anode electrode, and the additive agent disassembled under the influence of an anode electrode aims at providing the substrate plating device which does not adhere to a substrate to be plated.
[0009]
[Means for Solving the Problem]
In order to solve an aforementioned problem the invention according to claim 1, In a substrate plating device of composition of having arranged a substrate to be plated and an anode electrode which plate in a plating bath which accommodated a plating solution face to face, porosity neutral barrier membrane which has an ion-exchange membrane or a particle removal action between a substrate to be plated and an anode electrode has been arranged.
[0010]
By arranging porosity neutral barrier membrane which has an ion-exchange membrane or a particle removal action between a substrate to be plated and an anode electrode as mentioned above, An increase role of electrical resistance of a plating solution is played, the same effect as having enlarged distance between a substrate to be plated and an anode electrode is acquired, and this ion-exchange membrane or the porosity neutral barrier membrane can make an interval of a substrate to be plated and an anode electrode small.
[0011]
The invention according to claim 2 classified a plating bath into the plating board side field and the anode electrode side field by an ion-exchange membrane or porosity neutral barrier membrane in the substrate plating device according to claim 1.
[0012]
The invention according to claim 3 is an anode electrode of solubility [anode electrode] in the substrate plating device according to claim 1 or 2, and an ion-exchange membrane was used as cation exchange membrane which penetrates only ion which dissolved from an anode electrode.
[0013]
By considering it as cation exchange membrane which penetrates only ion which dissolved an ion-exchange membrane from an anode electrode as mentioned above, an impurity which dissolves from an anode electrode can be intercepted by this cation exchange membrane, and it becomes possible to lessen particle in a plating solution of the plating board side field as much as possible.
[0014]
In the substrate plating device according to claim 1, 2, or 3 the invention according to claim 4, An opening and closing valve was provided in an entrance of a plating solution of the anode electrode side field classified by an ion-exchange membrane or porosity neutral barrier membrane, and it constituted so that a plating solution of this anode electrode side field might join a plating solution which flowed out of the plating board side field via this opening and closing valve.
[0015]
Composition a plating solution from the anode electrode side field and a plating solution from the plating board side field are made to join as mentioned above, Namely, although particle is emitted into a plating solution with a black film which adhered to an anode electrode by constituting so that a plating solution from the anode electrode side field and a plating solution from the plating board side field may join on the outside of a plating bath, This particle is not mixed in a plating solution of the plating board side field.
[0016]
The invention according to claim 5 formed a filter in an exit of a plating solution of the anode electrode side field classified by an ion-exchange membrane or porosity neutral barrier membrane in the substrate plating device according to claim 4.
[0017]

By forming a filter in an exit of a plating solution of the anode electrode side field as mentioned above, particle emitted into a plating solution is removed from a black film adhering to an anode electrode by this filter.

[0018]

In a substrate plating device of composition of that the invention according to claim 6 has countered and arranged a substrate to be plated and an anode electrode which plate in a plating bath which accommodated a plating solution, An anode electrode was used as an anode electrode of insolubility, and barrier membrane which consists of porosity neutral barrier membrane or an anode ion-exchange membrane which has a particle removal action between this anode electrode and a substrate to be plated has been arranged.

[0019]

Since barrier membrane which consists of porosity neutral barrier membrane or an anode ion-exchange membrane which has a particle removal action between the above-mentioned anode electrode and a substrate to be plated has been arranged, Since a disassembled additive agent does not infiltrate into the plating board side field, without disassembling add-in material on the anode electrode surface since a fresh plating solution does not touch the anode electrode surface, a life of a plating solution becomes long.

[0020]

The invention according to claim 7 classified a plating bath into the plating board side field and the anode electrode side field by porosity neutral barrier membrane or an anode ion-exchange membrane in the substrate plating device according to claim 6.

[0021]

The invention according to claim 8 is in contact with a board which served as a shield with which porosity neutral barrier membrane or an anode ion-exchange membrane amends primary current distribution between an anode electrode and a substrate to be plated in the substrate plating device according to claim 6 or 7.

[0022]

A plating solution of the plating board side field where the invention according to claim 9 was classified by barrier membrane in the substrate plating device according to claim 6, 7, or 8, and the anode electrode side field is circulated by a separate circulation means, respectively.

[0023]

By circulating a plating solution of the plating board side field and the anode electrode side field by a separate circulation means as mentioned above, respectively, a plating solution which flows through the anode electrode side field flows outside together with O_2 gas which comes out from an anode electrode side apart from a plating solution which flows through a substrates face to be plated.

[0024]

[Embodiment of the Invention]

the following and an embodiment of the invention -- an example is explained based on a drawing. Drawing 1 is a figure showing the outline composition of the substrate plating device of this invention. In the figure, the portion which attached drawing 5 and identical codes shows a same or considerable portion. This substrate plating device arranges the cation exchange membrane 8 between the negative pole (substrate 2 to be plated) and the anode electrode 3 so that it may illustrate.

[0025]

As mentioned above, what is necessary is for what is necessary to be just to make it the primary current distribution between the substrate 2 to be plated and the anode electrode 3 become uniform, in order to raise the homogeneity of the plating film thickness of the surface of the substrate 2 to be plated, and just to enlarge distance between the substrate 2 to be plated and the anode electrode 3, in order to make this primary current distribution uniform. However, since the large plating bath 1 as mentioned above is needed if distance between the substrate 2 to be plated and the anode electrode 3 is enlarged, It was made to become equivalent to having enlarged distance between the substrate 2 to be plated and the anode electrode 3 here by arranging the cation exchange membrane 8 between the substrate 2 to be plated and the anode electrode 3, so that it may explain later. The cation exchange membrane 8 has classified the inside of the plating bath 1 into two fields of the arrangement area of the substrate 2 to be plated, and the arrangement area of the anode electrode 3.

[0026]

If the interval of the substrate 2 of the substrate plating device of the conventional composition to be plated and the anode electrode 3 which shows interval L_2 and drawing 5 the interval of the substrate 2 of the substrate plating device of this invention to be plated and the anode electrode 3 shown in drawing 1 is made into interval

L_1, even if it will similarly make primary current distribution uniform,

$L_1 >> L_2$

It becomes. That is, in the substrate plating device of this invention, interval L_2 between the substrate 2 to be plated and the anode electrode 3 can be made small making primary current distribution uniform as compared with a conventional example.

[0027]

Drawing 2 is a figure for explaining the effect which has arranged the cation exchange membrane 103 between the negative pole 101 and the anode 102. If it supposes that there is a level difference so that it may illustrate to the field of the negative pole 101 now, and i_1 and distance make [the current density of the portion of l_1] specific resistance of i_2 and plating solution Q the penetration electrical resistance R of rho and the cation exchange membrane 103 for the current density of the portion of l_2 in the distance between the negative pole 101 and the anode 102

$$i_2 / i_1 = (l_1 \rho + R) / (l_2 \rho + R)$$
$$= \{ (l_2 + \Delta l) \rho + R \} / (l_2 \rho + R)$$
$$= 1 + (\Delta l \rho) / (l_2 \rho + R)$$

It becomes.

[0028]

Therefore, in order to carry out the homogeneity of the primary current distribution, what is necessary will be just to bring current density ratio i_2/i_1 close to one. Instead of enlarging distance l_2 of the negative pole 101 and the anode 102 here, in order to bring current density ratio i_2/i_1 close to one, If the cation exchange membrane 103 which plays the role of the electrical resistance of a plating solution is arranged between the negative pole 101 and the anode 102, the same effect as having enlarged distance l_2 of the negative pole 101 and the anode 102 will be acquired. That is, in spite of having made inter electrode distance small by arranging the cation exchange membrane 103 between the negative pole 101 and the anode 102, an effect equivalent to having used big distance is acquired, and a substrate plating device can be made small by extension.

[0029]

A substrate plating device is used as Cu plating device which forms a Cu plated film in the substrate 2 to be plated in drawing 1, If it is considered as the cation exchange membrane which penetrates only the Cu ions which dissolved the cation exchange membrane 8 from the soluble anode electrode 3 when the anode electrode 3 is used as a soluble anode electrode and a plating solution is used as a copper sulfate solution, It becomes possible to intercept the impurity which dissolves from the anode electrode 3 by the cation exchange membrane 8, and it becomes possible to lessen particle in the plating solution of the substrate [to be plated] 2 side field as much as possible.

[0030]

Although the cation exchange membrane 8 has been arranged between the substrate 2 to be plated and the anode electrode 3 in the above-mentioned example, the same operation effect is obtained also by the porosity neutral barrier membrane which changes to this cation exchange membrane 8, and has a particle removal action.

[0031]

With electrical energy, the above-mentioned cation exchange membrane has the character to which permeation separation of the ion is carried out selectively, and can use a commercial thing. For example, there are a trade name by Asahi Glass Co., Ltd. "SEREMION", etc. As porosity neutral barrier membrane, the porous membrane which has a very small and uniform aperture which consists of synthetic resins is used. For example, a polyester nonwoven fabric is used for aggregate by Yuasa Ionics, Inc., and the quality of a film material uses the trade

name "YUMICRON" of polyvinylidene fluoride + titanium oxide.

[0032]

Drawing 3 is a sectional view showing the example of concrete composition of the plating bath of the substrate plating device of this invention. The plating bath 11 possesses the main part 15 of a plating bath, and the side plate 16 so that it may illustrate. The crevice 14 in which a plating solution is accommodated is formed in the main part 15 of a plating bath, and the lower end of the side plate 16 can open now and close the opening of the crevice 14 of the main part 15 of a plating bath by a hinge mechanism (not shown). The soluble anode electrode 17 is formed in the field by the side of the side plate 16 of the bottom plate 15a of the main part 15 of a plating bath, and the field by the side of the main part 15 of a plating bath of the side plate 16 is equipped with the substrate 18 which plates a semiconductor wafer etc. to be plated. Where the opening of the crevice 14 is closed with the side plate 16, the packing 20 contacts the field of the substrate 18 with which this side plate 16 was equipped to be plated, and let the crevice 14 of the main part 15 of a plating bath be a closed space.

[0033]

So that it may be located between the substrate 18 to be plated and the soluble anode electrode 17, where the side plate 16 is closed in the crevice 14 of the main part 15 of a plating bath, That is, cation exchange membrane or the porosity neutral barrier membrane 19 is formed so that the space of the crevice 14 may be classified into the plating board side field 14-1 and the anode electrode side field 14-2 (isolation). The upper header 12 and the lower header 13 are formed in the upper and lower sides of the main part 15 of a plating bath, and the opening 12a of the upper header 12 and the opening 13a of the lower header 13 are open for free passage to the plating board side field 14-1.

[0034]

The plating solution entrances 21 and 22 which are open for free passage to the vertical section of the anode electrode side field 14-2 are formed, The opening and closing valves 25 and 26 are formed in these plating solution entrances 21 and 22 via the filters 23 and 24, respectively, and these opening and closing valves 25 and 26 are further connected to the piping 27 connected to the opening 12a of the upper header 12, respectively, and the piping 28 connected to the opening 13a of the lower header 13. That is, the plating solution included in the plating board side field 14-1 of the main part 15 of a plating bath and the anode electrode side field 14-2 is divided on the outside of the main part 15 of a plating bath, and the plating solution which comes out joins on the outside of the main part 15 of a plating bath. Through the filters 23 and 24, the plating solution which comes out of the anode electrode side field 14-2 flows out, and ON is carried out. In drawing 3, 29 and 30 are check valves, respectively.

[0035]

In the plating bath 11 of the above-mentioned composition, plating solution Q from the piping 28 is supplied to the plating board side field 14-1 through the opening 13a of the lower header 13, and it is supplied also to the anode electrode side field 14-2 through the opening and closing valve 26 and the filter 24. By this, plating solution Q flows through the plating board side field 14-1 and the anode electrode side field 14-2, as shown in the arrow A, Plating solution Q of the plating board side field 14-1 flows into the piping 27 through the opening 12a of the upper header 12, and plating solution Q of the anode electrode side field 14-2 lets the plating solution entrance 21, the filter 23, and the opening and closing valve 25 pass, Plating solution Q from the plating board side field 14-1 which flows through the piping 27 is joined.

[0036]

Although particle arises in the plating solution of the anode electrode side field 14-2 with the black film adhering to the surface of the anode electrode 17 in the above substrate plating devices, So that this particle may not become together with plating solution Q of the plating board side field 14-1, Plating solution Q which flows out of the anode electrode side field 14-2 is constituted so that it may flow out of the plating board side field 14-1 through the filter 23 and the opening and closing valve 25 and may join on the outside of plating solution Q and the main part 15 of a plating bath.

[0037]

When picking out the substrate 18 to be plated from the plating bath 11, plating solution Q of the plating board side field 14-1 discharges, but as for plating solution Q of the anode electrode side field 14-2, it is not preferred to discharge in order to prevent the black film of the surface of the anode electrode 17 forming a white film. Then, it becomes possible to take out the substrate 18 to be plated, without discharging plating solution Q of the anode electrode side field 14-2 by closing the opening and closing valves 25 and 26, when picking out the substrate 18 to be plated from the plating bath 11.

[0038]
Although the above-mentioned example showed the example which passes plating solution Q from a lower part to the upper part to the plating board side field 14-1 of the main part 15 of a plating bath, and the anode electrode side field 14-2, It may be made to pass the flow direction of plating solution Q caudad from the upper part conversely, and may be made to pass it from the upper part by turns from a lower part and a lower part to the upper part. Predetermined voltage is impressed between the substrate 18 to be plated and the anode electrode 17.
[0039]
From the cation exchange membrane 19 being arranged between the substrate 18 to be plated and the anode electrode 17 as mentioned above. It becomes equivalent to the electrical resistance of plating solution Q between the substrate 18 to be plated and the anode electrode 17 having increased as mentioned above, The distance between the substrate 18 to be plated and the anode electrode 17 can carry out uniformly primary current distribution between the substrate 18 to be plated and the anode electrode 17 to it being small, and can form the plating film of uniform thickness in the surface of the substrate 18 to be plated.
[0040]
Since the cation exchange membrane 19 will penetrate only the Cu ions which dissolved from the soluble anode electrode 17 if the anode electrode 17 is used as a soluble electrode (copper plate) and plating solution Q is used as a copper sulfate solution, It becomes possible to intercept the impurity which dissolves from the anode electrode 17 by the cation exchange membrane 19, and it becomes possible to lessen particle in plating solution Q by the side of the substrate 18 to be plated as much as possible.
[0041]
Drawing 4 is a sectional view showing the example of concrete composition of the plating bath of the substrate plating device of this invention. The plating bath 11 shown in drawing 4 a different point from the plating bath 11 shown in drawing 3, It is the point of having arranged the barrier membrane 31 which consists of porosity neutral barrier membrane or an anode ion-exchange membrane between this anode electrode 33 and the substrate 18 to be plated, using the anode electrode of insolubility as the anode electrode 33, and having classified the plating bath 11 into the plating board side field 14-1 and the anode electrode side field 14-2. The barrier membrane 31 is formed in contact with the board 32 which served as the current shield for making primary current distribution uniform between the anode electrode 33 and the substrate 18 to be plated.
[0042]
In the plating bath 11 of the above-mentioned composition, although a graphic display is omitted, the plating solution which circulates through the plating board side field 14-1, and the plating solution which circulates through the anode electrode side field 14-2 are constituted, respectively so that it may be made to circulate with a separate circulating pump.
[0043]
As mentioned above, since the barrier membrane 31 which consists of porosity neutral barrier membrane or an anode ion-exchange membrane between the anode electrode 33 of insolubility and the substrate 18 to be plated has been arranged and a fresh plating solution does not touch the surface of the anode electrode 33, an additive agent is not disassembled and the life of plating solution Q becomes long.
[0044]
By circulating the plating solution of the plating board side field 14-1 and the anode electrode side field 14-2 with a separate circulating pump, respectively, The plating solution which flows through the anode electrode side field 14-2 flows outside together with O_2 gas which comes out from the field of the anode electrode 33 apart from the plating solution which flows through the 18th page of a substrate to be plated.
[0045]
[Effect of the Invention]
As explained above, according to the invention given in this application each claim, the following outstanding effects are acquired.
[0046]
Since the porosity neutral barrier membrane which has an ion-exchange membrane or a particle removal action between a substrate to be plated and an anode electrode has been arranged according to the invention according to claim 1 or 2, It can become equivalent to the electrical resistance of the plating solution between a substrate to be plated and an anode electrode having increased, primary current distribution between a

substrate to be plated and an anode electrode can be uniformly carried out to the distance of a substrate to be plated and an anode electrode being small, and a uniform plating film can be formed in the surface of a substrate to be plated. Therefore, the miniaturization of a substrate plating device can be attained.

[0047]

Since according to the invention according to claim 3 an anode electrode is a soluble anode electrode and the ion-exchange membrane was used as the cation exchange membrane which penetrates only the ion which dissolved from the anode electrode of this solubility, It becomes possible to intercept the impurity which dissolves from an anode electrode by cation exchange membrane, and it becomes possible to lessen particle in the plating solution by the side of a substrate to be plated as much as possible.

[0048]

According to the invention according to claim 4, an opening and closing valve is provided in the entrance and entrance of the anode electrode side field which were classified by an ion-exchange membrane or porosity neutral barrier membrane, So that the plating solution of this anode electrode side field may join the plating solution which flowed out of the plating board side field via this opening and closing valve Composition, That is, since it constitutes so that the plating solution of the anode electrode side field and the plating solution of the plating board side field may join on the outside of a plating bath, the particle emitted into the plating solution with the black film adhering to an anode electrode does not mix in the plating solution of the plating board side field.

[0049]

Since the filter was formed in the exit of the plating solution of the anode electrode side field classified by an ion-exchange membrane or porosity neutral barrier membrane according to the invention according to claim 5, particle arises in a plating solution with the black film adhering to an anode electrode, but. This particle is removed by this filter.

[0050]

Since the barrier membrane which consists of porosity neutral barrier membrane or an anode ion-exchange membrane between an anode electrode and a substrate to be plated has been arranged according to the invention according to claim 6, 7, or 8, Without a fresh plating solution touching the anode electrode surface, it can lose that the disassembled additive agent infiltrates into the plating board side field, and the life of a plating solution becomes long.

[0051]

By circulating the plating solution of the plating board side field and the anode electrode side field by a separate circulation means, respectively according to the invention according to claim 9, The plating solution which flows through the anode electrode side field is emitted outside together with O_2 gas which comes out from the field of an anode electrode apart from the plating solution which flows through the plating board side field.

[Brief Description of the Drawings]

[Drawing 1]It is a figure showing the outline composition of the substrate plating device of this invention.

[Drawing 2]It is a figure for explaining the effect which has arranged cation exchange membrane or porosity neutral barrier membrane between the negative pole and the anode of a substrate plating device.

[Drawing 3]It is a sectional view showing the example of concrete composition of the plating bath of the substrate plating device of this invention.

[Drawing 4]It is a sectional view showing the example of concrete composition of the plating bath of the substrate plating device of this invention.

[Drawing 5]It is a figure showing the outline composition of the conventional substrate plating device.

[Description of Notations]

1 Plating bath
2 A substrate to be plated
3 Anode electrode
4 Shield
5 Collecting gutter
6 Plating power supply
8 Cation exchange membrane or porosity neutral barrier membrane
11 Plating bath
12 Upper header

13 Lower header
14 Crevice
15 The main part of a plating bath
16 Side plate
17 Anode electrode
18 A substrate to be plated
19 Cation exchange membrane or porosity neutral barrier membrane
20 Packing
21 Plating solution entrance
22 Plating solution entrance
23 Filter
24 Filter
25 Opening and closing valve
26 Opening and closing valve
27 Piping
28 Piping
29 Check valve
30 Check valve
31 Barrier membrane which consists of porosity neutral barrier membrane or an anode ion-exchange membrane
32 The board which served as the shield
33 Anode electrode

[Translation done.]